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Computer programs for ultimate strength of longitudinally stiffened panels (large b/t), August 1967

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Built-Up Members in Plastic Design

COMPUTER PROGRAM FOR ULTIMATE STRENGTH OF LONGITUDINALLY STIFFENED PANELS (LARGE b/t)

by

Joseph F. Vojta

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INTRODUCTION

Longitudinally stiffened plate panels are commonly used as structural elements of ship hulls (Fig. 1). A knowledge of the structural behavior of the plate panels is thus very important in ship design. For this reason research studies have been conducted at Lehigh University to determine the ultimate strength of longitudinally stiffened plate panels.[(1)(2)(3)(4)] Computer programs have been used to perform the many numerical operations involved in using the theories developed by the research studies.[(1)(3)(5)]

This report describes a computer program that analyzes a stiffened plate panel and determines the maximum fixed and simply-supported lengths that it can have under the given loading conditions*. The cross section considered is shown in Fig. 2**. The computer program in this report analyzes panels where the main element of the cross section is a plate having the ratio of stiffener spacing to plate thickness (b/t) sufficiently large (≥ 45) so that the plate buckles before the ultimate load is reached***. The program in this report was used extensively in obtaining the data for the ultimate strength design curves of References 3 and 4.

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*The loading conditions are given in more detail in Ref. 3.

**More information concerning the cross section, residual stress condition, and plate buckling action is contained in Ref. 3.

***Reference 5 contains a computer program which analyzes, with more accuracy, the case where b/t is less than 45.

The analysis performed by the computer program is essentially in two parts. The main program evaluates the response of the cross section to the given loading conditions in the form of a moment-curvature-thrust, (m-ϕ-P), curve for a given axial load. This curve is then used in a numerical integration of small segments which yields the maximum fixed and simply-supported lengths for each of a series of mid-span starting curvatures. From the plot of maximum lengths vs. the mid-span starting curvatures, Fig. 3, the program uses a parabolic interpolation technique to obtain the maximum length the panel can have under the given loading condition. Seperate curves and maximum lengths are found for the fixed and simply-supported ends.

The analysis considers non-linear effects, non-symmetrical cross sections, and inelastic behavior. The effects of residual stresses in the plate and different yield stresses in the plate and stiffener are also considered.

Some important factors concerning the use of the computer program are:

1) The program continuously loops the input parameters as specified by the user. Thus a series of cross sections can be obtained with a minimum amount of input cards required.
2) The program is self regulatory in that important control values can be input as constant values for all cross sections to be run. The program internally modifies these values to adjust for changes in the cross section for the particular case being analysed.

3) The input and the resulting output are printed and are also punched on computer cards. The punched results facilitate further use and arrangement of the data.

4) Provision has been made to label each run with an identifying number chosen by the user.

5) When the input is such that the no meaningful results can be obtained the program proceeds to the next case and prints out the reason why the particular case could not be run.*

This report deals with the preparation of input data for the program, technical information about the program and its use, and an explanation of the printed and punched output. The appendix presents the program and an example of the output. In arranging this report an attempt has been made to conform to the standards of Ship Design Division Instruction 10462 of the Bureau of Ships, U. S. Navy.

*One particular case of importance occurs when the axial load is very high for certain cross sections. The moment-curvature curve in this case has only negative (compression in plate due to bending) bending moments for all values of curvature. This means that under only axial load the section requires an application of an external moment in order to obtain equilibrium. The computer program cannot handle this case and this information is printed in the results.

PART I - IDENTIFICATION

1. Title: Computer Program for Ultimate Strength of Longitudinally Stiffened Panels (Large b/t)

2. Brief Description: An m-Ø-P curve is computed for the cross section being analyzed. Then, for the given loading the program makes successive computations of both the simply-supported and fixed end panel lengths for each of a series of mid-span curvatures. By comparing each new set of lengths with the previous set, the maximum set is determined.

The program consists of four main parts:

1) The MAIN program which computes the m-Ø-P curve for constant axial load for the cross section being analyzed.
2) Subroutine INTEG which numerically integrates a series of small segments to determine the simply-supported and fixed end lengths for a given combination of axial and lateral load. This is done for a series of mid-span curvatures and the maximum length values are interpolated from the curve that results.
3) Function BC which finds the zero root of a parabolic equation by using Newton's Method for Finding Zeros.
4) Function VAL which calculates an intermediate point on a parabola when given three points.
5) Subroutine PARAM which regulates the increment in curvature required before printing a point on the m-Ø-P curve. This subroutine also adjusts the increment of plate strain depending on the cross section being used.

6) Function CUR which provides an estimate of the initial mid-span curvature.

7) Subroutine VALUES which regulates the increments of center curvature and of segment length to adjust for the case being run.

Input data are read directly from cards into the main program. The main program will iterate through successive sets of data and will be used for each cross section specified on the cards. After each time through the main program, subroutine INTEG will be called and will be cycled for each lateral load specified in the input for the given cross section. The other subprograms are called for and used at various times throughout the use of the main program and subroutine INTEG.

3. a) Author: Jun Kondo,* Tsuneo Tsuiji,* Joseph F. Vojta, and Alexis Ostapenko

b) Date: August, 1967

4. Code: Fortran II

5. Machine: GE 225 (any other machine that compiles Fortran II may be used)

6. Security Classification: Unclassified

7. Estimated Running Time: Main program 90 sec.

INTEG** 50 sec.

140 sec.

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*Developed part of this program before it was modified into its present form.

**This time is estimated for each lateral load

PART II - PURPOSE & METHOD

1. Description of Theory: See ULTIMATE STRENGTH DESIGN OF LONGITUDINALLY STIFFENED PLATE PANELS WITH LARGE b/t, by Joseph F. Vojta and Alexis Ostapenko, Fritz Engineering Laboratory Report No. 248.18, Lehigh University, 1965.

2. Assumptions:*

   a) No local buckling of any elements except the main plate element.

   b) The plate is assumed to be simply-supported at the stiffeners.

   c) The distribution of the residual stresses in the plate is assumed to be rectangular. The residual stresses in the flange have a small effect and are neglected.

   d) The postbuckling action in the plate is assumed to be governed by Koiter's equation until its maximum stress is reached.

3. References: See REFERENCES at the end of this report.

PART III - RESTRICTIONS

1. General Restrictions: None

2. Limitations for Use:

   a) The program will not run for extremely high axial loads where the bending moment is negative for all values of curvature. The program exits and prints "No Positive Bending Moment Capacity (CMX1 is negative) CMX1 = XXXX.XXXX".

*For further information see Ref. 3.

b) Acceptable results are not produced in all cases when the mid-span curvature for the simply-supported length is less than the mid-span curvature for the corresponding fixed-end length. This is denoted when the computer prints "ERROR**IS EXCEEDS 2". Under normal conditions this will not occur or will occur very infrequently.

3. Nonstandard Hardware & Tapes: None

4. Maximum Array Sizes: 7 Arrays are used: FI (200)
GM (200)
P (30)
R (20)
Q (10)
Y (30)
X (25)

PART IV - NONSTANDARD MACHINE OPERATING INSTRUCTIONS

1. Special Operating Instructions: None
2. Restart Instructions: None
3. Error Correction: None

PART V - DATA PREPARATION

1. Card Input Form:

Card	Format	Variable Names	Comment
1	I3	NN	Number of data sets to be run (i.e. times computer must read through cards 2 - 13)

Card	Format	Variable Names	Comment
2	I5, I2	NRUN, IALL	Case number, number of first the lateral load, respectively.
3	F7.0	R(6)	Modulus of elasticity (ksi)
4	"	RX	Nondimensional strain increment, $\frac{\Delta \epsilon_e}{\epsilon_{cr}}$ (Use about 0.003 for most cases)
5	2F7.6	DSI, FIC	Nondimensional segment length and nondimensional increment of mid-span curvature. $\frac{\Delta s}{r}\sqrt{\epsilon_{yp}}$, $\left(\frac{\phi}{\phi_{cr}}\right)_0$ (Generally use 0.12, 0.20)
6	2F7.2,3I2, 2F7.2, I2	QL1,QLIC,NSUM, LT,IALLA,QL1A, QLICA,NSUMA	First three values for "loop"* of QLL, then punch 1 for another "loop", 0 for no other loop, the lateral load number for the second "loop", then last three values for the second "loop". QLL=q($\frac{a}{t}$) where q is in psi.
7	2F7.2, I2	R4N,R4I,NR4	Stiffener yield stress (ksi) ("loop" of R(4))
8	" "	R5N,R5I,NR5	Plate yield stress (ksi)("loop" of R(5))
9	" "	ASTN,ASTI,NAST	Nondimensional area of stiffener ("loop" of AST")
10	" "	AFSN,AFSI,NAFS	Nondimensional area of flange ("loop" of AFS)
11	" "	RESN,RESI,NRES	"Loop" of compressive residual stress $\frac{\sigma r}{\sigma_{yp}}$
12	" "	BN,BI,NRB	"Loop" of b/t
13	" "	R1N,R1I,NR1	"Loop" of axial load (P/P_{cr})

*"loop" means first value, increment of value, total number of values to be used (including the first value). For example 2.12 0.50 4 means run the values 2.12, 2.62, 3.12 and 3.62.

If card 1 has a value greater than 1, cards 7 to 13 must be repeated the required number of times.

Last card - Any illegal character on a data card will terminate the run. Such an illegal character can be END OF DATA.

2. Sample Input:

Card No.		
1		1
2		77 1
3		29600
4	*	0.003
5		0.1200 0.20000
6	**	40.0 140.0 3 1 $ 110.0 20.0 1
7	**	47.0 33.0 1
8	**	47.0 33.0 1
9	*,**	0.34 0.14 2
10	*,**	0.60 0.05 1
11	**	0.075 0.075 1
12	**	110.0 10.0 1
13	**	1.3 0.1 1

*This does not conform to the specified format. However, the decimals punched in the input data cards have priority over the decimal location specified in the input format.

**The input value specifying the increment to be used has no meaning because the last input (1) specifies no "loops". Any arbitrary value can thus be used for the increment.

The example run shown in the appendix uses this data. However card 9 specifies that the run is to continue on for a new value of AST. Thus run number 78 would be similar to run 77 except that it would have a value of 0.48 for AST.

Card 6 describes the looping of the lateral load parameter QLL. The values of QLL will be 40, 180, and 320 for the first loop corresponding to lateral load numbers 1, 2, and 3, (see card 2). Then it loops again (1 in column 18) and gives a value of QLL = 110 for lateral load number 6 (column 20).

3. Output Form Description:

Page	Comment
1	Lists input and some computed values for checking and later identification. Some of the values that are not so easily identified are:

AF = area ratio, flange to total

AW = area ratio, web to total

AP = area ratio, plate to total

CT = nondimensional distance from the plate to the centroidal axis

SM = nondimensional section modulus, $\frac{S}{Ad}$

MAX LOAD = maximum external panel load

STIFF YIELD = ratio of stiffener yield stress to critical stress

PLATE YIELD = ratio of plate yield stress to critical stress

MAX PL STRESS = nondimensional plate stress computed from Koiter's Equation(3)

Page	Comment
	In addition the printouts on page 1 include points on the moment-curvature plot for the various corresponding values of plate strain, $\frac{\epsilon}{\epsilon_{cr}}$ *.
2,3,&4	Continues listing of 200 points the moment-curvature plot.
5	Lists results for each parameter QLL. Values for both the maximum ultimate lengths for both the simply-supported and fixed end cases are printed out. Also listed are the corresponding mid-span curvature, end moment, and axial load at the ends, all nondimensionalized by the critical value. In addition, listings are made of the total panel length, chord length, and center deflection all nondimensionalized by the radius of gyration of the idealized cross section**. The slope in radians is printed.

In addition to the errors listed in Part III, the following error messages are printed if the error does occur.

Message	Comment
a) LL EXCEEDS 10	This is a check on the internal computations in the m-Ø-P calculations. If this occurs the results are not correct.

*The symbols used, if not defined, correspond to those used in Reference 3.

**See Ref. 3 for "idealized" cross section.

b) INITIAL PHC TOO HIGH	The initial estimate of mid-span curvature is too high. Revisions in Function CUR are then required.
c) TOO MANY PHC VALUES REQUIRED. USE A LARGER FIC	The increment in mid-span curvature is too small. Increase the value of FIC in input card 5.
d) TOO MANY LENGTH INCREMENTS	Increase DSI in input card 5. The increment of segment length is greatly reduced for segments computed after the simply-supported length has been computed but the fixed end length is being calculated for a particular mid-span curvature. This type of error becomes a problem for very high axial loads because then the simply-support length is low but the fixed end length is high and many segment lengths are required.
e) CURVATURE OUTSIDE LIMITS OF M-PHI-P CURVE	The limits of the maximum curvature values computed in the m-ϕ-P plot are not wide enough. To remedy this, increase the value of RX in input card 4.

4. Symbol List and Definitions

AST	Area of Stiffener divided by area of plate
ASTI	Increment of AST
ASTN	Initial value in "loop" of AST

AFS	Area of flange divided by area of stiffener
AFSI	Increment of AFS
AFSN	Initial value in "loop" of AFS
B	Width-thickness ratio (b/t) of plate
BC1, BC2, BC3, BC4	Dummy variables in Function BC
BI	Increment of B
BN	Initial value in "loop" of B
CA	Dummy variable in Function VAL, intermediate value in Subroutine INTEG
CB	In the main program CB is the width of the tensile residual stress zone divided by the flange width; dummy variable in Function VAL; intermediate value in Subroutine INTEG
CC	Mid-span curvature corresponding to the ultimate condition, ie. $(\phi/\phi_{cr})_{o_{ULT}}$ where $\phi_{cr} = \frac{\epsilon_{cr}}{\alpha d}$, and α = nondimensional distance from plate to centroidal axis
CD	Computed axial load at the end of the panel divided by the critical axial load P_{cr}, where P_{cr} = (panel area, A) x (critical buckling stress, σ_{cr})
CM	Moment array, Bending moment divided by the critical moment for the main program and by the yield moment for subroutine INTEG
CMX1, CMX2	Positive and negative bending moment capacities of the cross section (nondimensional)

GR	Nondimensional radius of gyration
CRS	Plate compressive residual stress divided by the critical buckling stress, σ_{cr}
CS	Cosine of slope angle
C11, C12	Dummy variables in Function VAL
DEFA	Difference in curvatures
DSI	Increment of segment length (see Part V)
DSIA	Modifying factor for increment of segment length
DSII	Modified increment of segment length (Adjusts for specific cross section being analyzed)
DST	Intermediate segment length value
EFIX	Final maximum panel length for fixed end case, $(\frac{\ell}{r})^F_{max.}$
EMOM	End moment corresponding to the maximum ultimate condition. Also used as a storage location for various values of differences in sines of slope angles
EPIN	Final maximum panel length for simply-supported ends, $(\frac{\ell}{r})^P_{max.}$
EY	Plate yield strain, $\frac{\epsilon_{YP}}{\epsilon_{cr}}$
FI	Curvature array. Curvature divided by critical curvature in the main program, and by the yield curvature in Subroutine INTEG
FIC	Increment of mid-span curvature (see Part V)
FICA	Modifying factor for increment of mid-span curvature
FII	Modified increment of mid-span curvature (modified for the particular cross section being analyzed and non-dimensionalized by the critical curvature)

FOI	Modified increment of mid-span curvature (modified for the particular cross section being analyzed and nondimensionalized by the critical curvature)
I	Counter of how many terminal curvatures have been assumed
IA	Counter in main program and in Subroutine INTEG
IAFLL	Storage location for number assigned to the original IALL value
IALL	Number assigned to the first lateral load in the first "loop" of lateral loads
IALLA	Number assigned to the first lateral load in the second "loop" of lateral loads
IB	Counter to determine which end conditions have been determined (S.S. or fixed)
IC	Counter to see if the ultimate simply-supported length has already been determined
ID	Similar to IC but for each assumed mid-span curvature
IE	Counter for determining if the simply-supported length has already been determined for each assumed mid-span curvature
II	Counter of lateral loads used in each "loop" of lateral loads
INUM	Number of the lateral load presently being run
J	Counter that relates the curvature equation to its corresponding moment equation
JA	Counter of how many mid-span curvature increments have been used
JB	Counter of how many segment length increments have been used

JAFS	Counter of how many values of AFS have been used
JAST	Counter of how many values of AST have been used
JBB	Counter of how many values of B have been used
JRBS	Counter of how many values of RBS have been used
JR1	Counter of how many values of R(1),(i.e. axial load), have been used
JR4	Counter of how many values of R(4),(i.e. stiffener yield stress), have been used
JR5	Counter of how many values of R(5),(i.e. plate yield stress), have been used
K	General counter
KK	Counter of how many trial slopes for Newton's Method have been used in Function BC
L	Counter of how many times curvatures are computed and compared to assumed curvatures
LL	Counter to check for errors
LRUN	Number of the case being run (m-ϕ-P)
LS	Counter of how many complete lateral load "loops" were run
LT	Amount of excess lateral load "loops" prescribed in input
N	Counter of points on m-ϕ-P curve. 100 points for negative bending and then 100 points for positive bending
MAFS	Number of values in "loop" of AFS
MAST	Number of values in "loop" of AST
MBB	Number of values in "loop" of B
NFSUM	Number of values in original "loop" of QLL

NN	Number of sets of input data cards
NRES	Storage location for the number of values in "loop" of RES
NRUN	Number assigned to original run number
NR1	Number of values in "loop" of R(1)
NR4	Number of values in "loop" of R(4)
NR5	Number of values in "loop" of R(5)
NSRM	Number of values in "loop" of QLL (original loop)
NSRMA	Number of values in "loop" of QLL (second loop)
P	Array which generally is used to store stresses and strains
PHC	Mid-span curvature, ϕ/ϕ_{cr}
PHC1	Mid-span curvature, ϕ/ϕ_{yp}
PNT1	Nondimensional distance (α) from the plate to the neutral axis
PSX1	Maximum plate load corresponding to the maximum positive moment
PSX2	Maximum plate load corresponding to the maximum negative moment
Q	Array of relative area ratios
QFLIC	Storage location for lateral load increment in the first lateral load loop
QFL1	Storage location for first lateral load value in first lateral load "loop"
QIR	$\frac{qbE_{cr}d}{\sigma_{yp}^{2}A}$

where

q = hydrostatic lateral pressure (psi)

b = plate width or stiffener spacing

E = modulus of elasticity

α = nondimensional distance from the plate to the centroidal axis

d = depth of stiffener (in.)

σ_{yp} = yield stress in the stiffener

A = area of portion of panel being analyzed

QLIC Increment of lateral load parameter QLL for first "loop"

QLICA Increment of lateral load parameter QLL for second "loop"

QLL Lateral load parameter q (d/t)

where

q = see QIR

d/t = ratio of depth of stiffeners to thickness of plate

QL1 First lateral load parameter in first "loop" of lateral load

QL1A First lateral load parameter in second "loop" of lateral load

R Array which generally stores load parameters

RES Plate compressive load parameter, σ_r/σ_{yp}

where

σ_r = plate compressive residual stress

σ_{yp} = (see QIR)

RESI	Increment in "loop" of RES
RESN	Number of increments in "loop" of RES
REY	Square root of plate yield stress
RIN	Storage for important plate strain values
RMAX	Maximum plate strain
RX	Input value of increment of plate strain, $\frac{\Delta \epsilon_e}{\epsilon_{cr}}$ where ϵ_e is the increment of plate strain $\epsilon_{cr} = \frac{\sigma_{cr}}{E}$
R1I	Increment in "loop" of axial load parameter R(1) where $R(1) = P/P_{cr}$, P = axial load, P_{cr} = (see CD)
R1N	Number of increments in "loop" of R(1)
R4I	Increment in "loop" of stiffener yield stress
R4N	Number of increments in "loop" of stiffener yield stress
R5I	Increment in "loop" of plate yield stress
R5N	Number of increments in loop of stiffener yield stress
R8	Plate strain increment used only in the range of high moment values in positive bending portion of m-Ø-P curves
R8A	Plate strain increment generally used
SN	Sine of slope angle
STFN	Stiffener flange strain corresponding to maximum moment capacity
TLEN	Maximum ultimate panel length, or storage location for increment in chord length

VAL1, VAL2, VAL3, VAL4 Dummy variables in subroutine VAL

XLEN Maximum ultimate panel length, or storage location for increment of center deflection

The following variables and arrays are intermediate and have no general definition

BK	FIX2	T
C	FS	V
C1	FST	W
C2	F1	X*
C3	F2	Y*
C4	F3	ZI
C5	GH	ZJ
C13	HS	ZK
C14	PSX3	ZL
F	RPL	ZM
FIX1	SP	ZN

*Array

FIGURES

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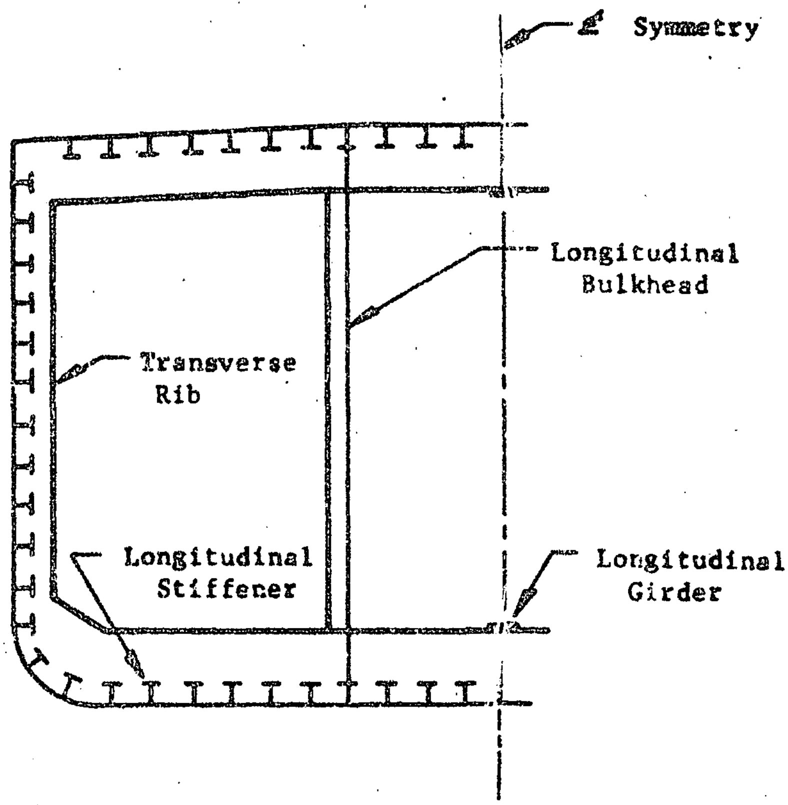
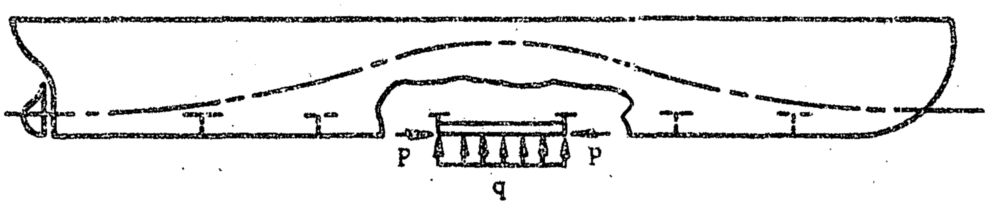
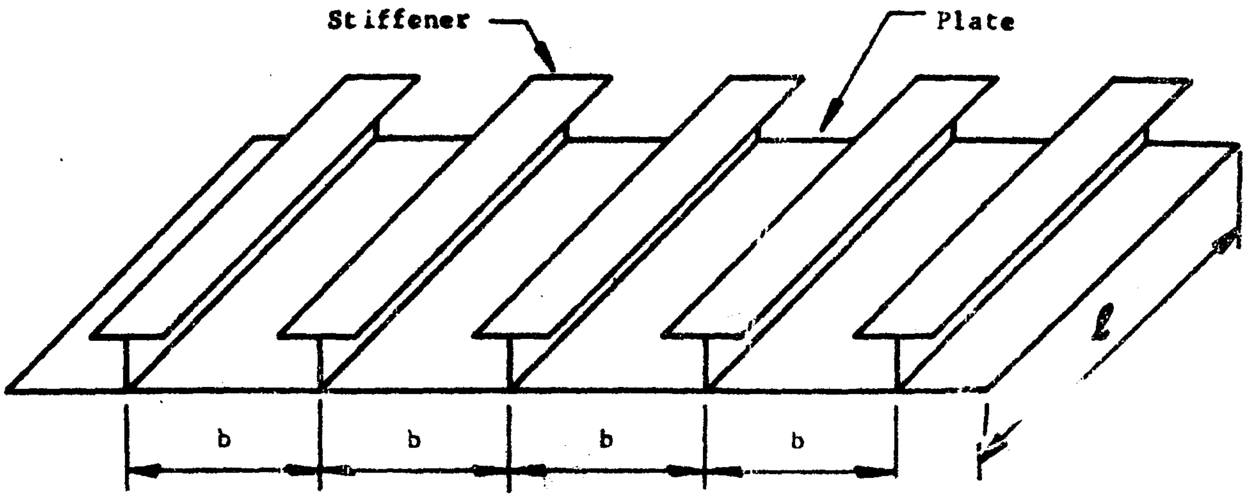


(a) TYPICAL MID-SHIP CROSS SECTION

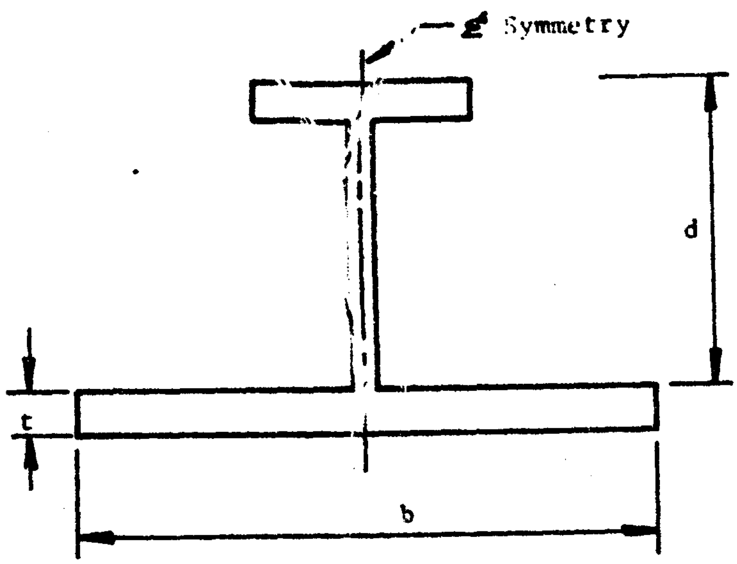


(b) LOADING ON THE SHIP BOTTOM PANEL DUE TO WAVE ACTION-HOGGING

Fig. 1 LONGITUDINALLY STIFFENED PLATE PANELS IN THE SHIP BOTTOM STRUCTURE.



(a) TYPICAL CROSS SECTION OF A SHIP HULL



(b) TYPICAL SECTION USED BY COMPUTER PROGRAM

Fig. 2 CROSS SECTIONS BEING ANALYZED

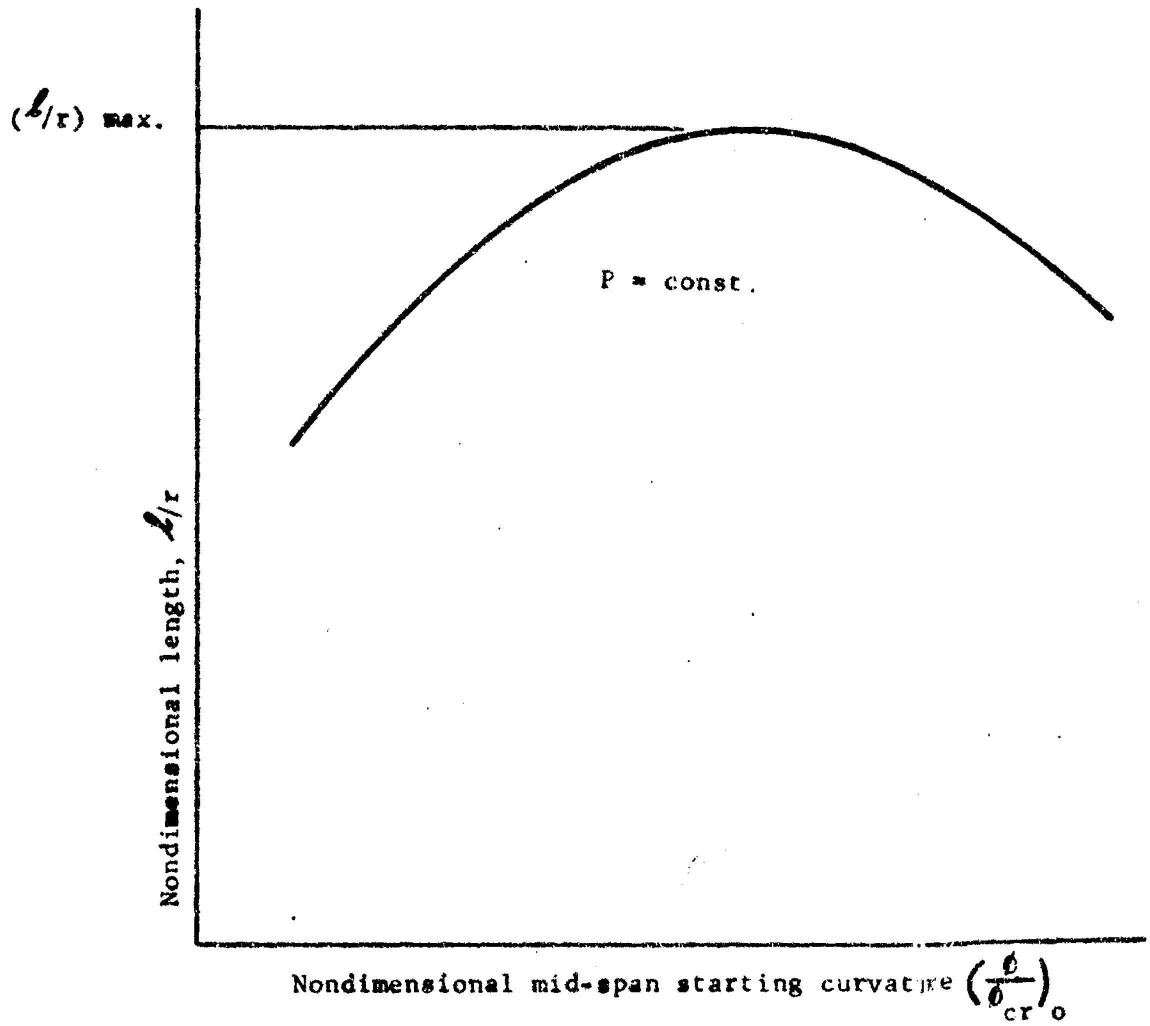


Fig. 3 DETERMINATION OF MAXIMUM LENGTH

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The author is indebted to Mr. John M. Gera, Jr. for helping prepare the drawings and to Miss Flo Ann Saeger for typing the manuscript.

APPENDIX

MAIN PROGRAM


```
C     THIS IS THE MAIN PROGRAM. IT COMPUTES A MOMENT-CURVATURE CURVE
C     FOR A GIVEN AXIAL LOAD.
C
C
C     THE FOLLOWING QUANTITIES ARE PLACED IN COMMON SO THAT MORE SPACE
C     IS LEFT AVAILABLE FOR THE STORAGE OF VALUES USED IN THE COMPUTER
C     PROGRAMS
C
      COMMON R(30),C(10),P(30),FI(200),CM(200),LRUN,NSUM,X(25),Y(30),RSS
      COMMON R,QL1,QLIC,DSI,FIC,AST,AFS,CMX1,CMX2,PNT1
      COMMON NN,NRUN,R4N,R4I,NR4,R5N,R5I,NR5,ASTN,ASTI,NAST,AFSN,AFSI
      COMMON NAFS,RESN,RESI,NRES,RN,RI,NRB,R1N,R1I,NR1,   RMAX,PSX1,SYFN
      COMMON PSX2,RPL,V,W,T,J,DEFA,LL,PSX3,RIN,L,IALL
      COMMON C,INUM,REY,EY,CP,PHC,QIP,JA,IB,IC,ID,IE
      COMMON DST,SN,CS,JB,C1,C2,C3,C4,C5,C11,PHC1,C13,C14,FMOM,CA,CC,CD
      COMMON TLEN,XLEN,EFIX,EPIN
      COMMON LT,IALLA,QL1A,QLICA,NSUMA,F1,RK,F2,F3,GH,FS,Z1,ZJ,ZK,ZL,ZM
C
C     READ NUMBER OF CYCLES
C
      READ 65,NN
   65 FORMAT(I3)
      II=1
C
C     READ RUN NUMBER (NRUN) AND NUMBER OF LATERAL LOAD BEING RUN (SET
C     NO., IALL)
C
   19 READ 20,NRUN,IALL
   20 FORMAT(I5,I5)
      LRUN=NRUN-1
C
C     READ MODULUS OF ELASTICITY (K.S.I.)
C
   74 READ 75,R(A)
   75 FORMAT(F7.0)
C
C     READ STRAIN INCREMENT(RATIO OF CRITICAL PLATE STRAIN)(NEG. BEND.
C
      READ 75,RK .
C
C     READ INCREMENT OF SEGMENT LENGTH (NON-DIMENSIONALIZED BY
C     MULTIPLICATION BY REY/R, WHERE R IS THE RADIUS OF GYRATION AND REY
C     IS THE SQUARE ROOT OF THE PLATE YIELD STRAIN), INCREMENT OF
C     MID-HEIGHT CURVATURE (NON-DIMENSIONALIZED BY DIVISION BY THE
C     CRITICAL PLATE CURVATURE)
C
      READ 145,DSI,FIC
  145 FORMAT(2F7.4)
C
C     READ LATERAL LOAD (Q*D/T.Q IN P.S.I.) (LOOP .I.E. INITIAL.
C     INCREMENT,NO. OF VALUES),SIGNAL OF MORE LATERAL LOADS. LOOP OF
C     POSSIBLE ADDITIONAL LATERAL LOADS
C
      READ 116,QL1,QLIC,NSUM,LT,IALLA,QL1A,QLICA,NSUMA
  116 FORMAT(2F7.2,3I2,2F7.2,I2)
```

```
C
C
C     READ YIELD STRESS OF STIFFENER (K.S.I.) (LOOP)
C
          READ 115,R4N,R4I,NR4
      115 FORMAT(2F7.2,I2)
C
C     READ YIELD STRESS OF PLATE (LOOP) (K.S.I.)
C
          READ 115,R5N,R5I,NR5
C
C     READ AREA RATIO(STIFFENER TO PLATE) (LOOP)
C
          READ 115,ASTN,ASTI,NAST
C
C     READ AREA RATIO (FLANGE TO STIFFENER) (LOOP)
C
          READ 115,AFSN,AFSI,NAFS
C
C     READ RESIDUAL STRESS IN PLATE (AS RATIO OF PLATE YIELD STRESS)
C     (LOOP)
C
          READ 115,RESN,RESI,NRES
C
C     READ B/T (LOOP)
C
          READ 115,BN,BI,NBB
C
C     READ AXIAL LOAD (AS RATIO OF CRITICAL LOAD) (LOOP)
C
          READ 115,R1N,R1I,NR1
C
C     BEGIN LOOPING PARAMETERS
C
          R(4)=R4N-R4I
          DO 2270 JR4=1,NR4
          R(4)=R(4)+R4I
          R(5)=R5N-R5I
          DO 2270 JR5=1,NR5
          R(5)=R(5)+R5I
          AST=ASTN-ASTI
          DO 2270 JAST=1,NAST
          AST=AST+ASTI
          AFS=AFSN-AFSI
          DO 2270 JAFS=1,NAFS
          AFS=AFS+AFSI
          RES=RESN-RESI
          DO 2270 JRES=1,NRES
          RES=RES+RESI
          B=BN-BI
          DO 2270 JBB=1,NBB
          B=B+BI
          R(1)=R1N-R1I
          DO 2270 JR1=1,NR1
          R(1)=R(1)+R1I
C
```

```
C
C     COMPUTE CROSS-SECTION VALUES
C
      P(1)=(1.+AST)/(1.-AFS)
      Q(1)=AST+AFS*(1./(1.+AST))
      Q(2)=AST/P(1)
      Q(3)=1./(1.+AST)
      P(2)=Q(1)+Q(2)
      Q(4)=P(2)-0.5*Q(2)
      P(3)=1.-Q(4)
      Q(5)=(Q(1)/Q(4)+2.-3.*Q(4))/3.
      PRINT 62
   62 FORMAT(1H1,43X,32H ***MOMENT CURVATURE RELATION***//////)
C
C     LRUN IS THE COUNTER OF THE RUN BEING EXECUTED
C
      LRUN=LRUN+1
      PRINT 15,LRUN
   15 FORMAT(52X,11HRUN NUMBER ,I5,//)
C
C     PRINT X-SECTION PROPERTIES
C
      PRINT 180,AST,AFS,R,Q(1),Q(2),Q(3),Q(4),Q(5)
  180 FORMAT(5X,4HAST=,F8.6,2X,4HAFS=,F8.6,3X,4HR/T=,F7.3,    3X,3HAF=,F
     18.6,3X,3HAW=,F8.6,3X,3HAP=,F8.6,3X,3HCT=,F8.6,3X,3HSM=,F8.6//)
C
      P(4)=0.27561*R*R/R(6)
      CRS=RES*R(5)*P(4)
      R(10)=P(4)*R(4)
      R(11)=P(4)*R(5)
      CB=CRS/(CRS+R(11))
C
C     PARAM ADJUSTS THE STRAIN INCREMENT FOR THE CROSS-SECTION BEING RUN
C
      R(8)=RX
      CALL PARAM(HS,RAA,RB)
C
C     COMPUTE MAX. PLATE STRAIN
C
      IF(R(11)-1.)252,252,259
  252 R(12)=R(11)
      RMAX=R(11)
      GO TO 261
  259 R(7)=1.
  260 R(12)=1.2*R(7)**0.6-0.65*R(7)**0.2+0.45*R(7)**(-0.2)
      R(16)=0.5*(3.*(1.-CB)*(1.-CB)-1.)*R(7)+1.5*(1.-(1.-CB)*(1.-CB))*R(
     112)
      IF(R(16)-R(11))3,5,5
    3 R(7)=R(7)+R(8)
      GO TO 260
    5 RMAX=R(7)
C
C     COMPUTE LOCATION OF NEUTRAL AXIS (PNT1) AND MAX. PLATE STRESS AND
C     MAX. MOMENTS RESP. (PSX1 AND CMX1 FOR POS. BEND., PSX2 AND CMX2 FO
C     R NEG. BEND.)
C
```

C


```
  261 P[5]=Q[3]*[R[12]-QRR]
      PNT1=0.5*[R[1]+R[10]*P[2]-P[5]]/[R[10]*Q[2]]
      IF[PNT1]275,267,267
  267 IF[PNT1-1.]268,268,271
  268 CMX1=[2.*PNT1*[Q[4]-0.5*PNT1]*R[10]*Q[2]+Q[4]*[R[10]*Q[3]+P[5]]]/Q
     1[5]
      PSX1=R[12]
      GO TO 280
  271 STFN=[-Q[2]*R[10]-P[5]+R[1]]/Q[1]
      PSX1=[R[1]-Q[1]*STFN-R[10]*Q[2]]/Q[3]
      CMX1=[P[3]*[R[10]-STFN]*Q[1]-Q[4]*[R[10]*Q[3]-P[5]]]/Q[5]
      GO TO 280
  275 PSX1=[R[1]+R[10]*P[2]]/Q[3]
      CMX1=Q[4]*[R[10]+PSX1]*Q[3]/Q[5]
  280 PSX2=[R[1]-R[10]*P[2]]/Q[3]
      CMX2=-Q[4]*[R[10]-PSX2]*Q[3]/Q[5]
      IF[CMX1]308,308,310
  308 PRINT 309,CMX1
  309 FORMAT[25X,                62HNO POSITIVE BENDING MOMENT CAPACITY
    1 [CMX1 IS NEGATIVE]   CMX1=,F9.4]
      GO TO 2270
  310 R[3]=P[2]*R[10]+P[5]
      PRINT 330,R[3],R[10],R[11],R[12],RMAX
  330 FORMAT[  5X,9HMAX LOAD=,F9.6,2X,12HSTIFF YIELD=,F9.6,2X,12HPLATE Y
    1IELD=, F9.6,2X,12HMAX PL STRS=,F9.6,2X,12HMAX PL STRN=,F9.6//]
      PRINT 333,PSX1,CMX1,PNT1,PSX2,CMX2
  333 FORMAT[  9X,5HPSX1=,F9.6,8X,5HCMX1=,F9.6,8X,5HPNT1=,F9.6,8X,5HPSX2
    1=,F9.6,8X,5HCMX2=,F9.6//]
      IA=1
C
C     N LESS THAN 100 FOR NEG. BEND.
C     N GREATER THAN 100 FOR POS. BEND.
C
      N=100
      R[7]=R[1]
      GO TO 2050
  360 RIN=R[7]
      PRINT 370,R[1],RES,CR,R[8]
  370 FORMAT[17X,11HAXIAL LOAD=,F6.3,4X,20HPLATE RESID. STRESS=,F5.3,4X,
    14HC/R=,F5.3,4X,17HSTRAIN INCREMENT=,F6.3//]
      PRINT 365,R[6],R[5],R[4]
  365 FORMAT[15X,19HMOD. OF ELASTICITY=,F7.1,5X,19HPLATE YIELD STRESS=,F
    17.3,6X,20HSTIFF. YIELD STRESS=,F7.3,///]
      PRINT 390
  390 FORMAT[ 39X,6HSTRAIN,6X,9HCURVATURE,7X,6HMOMENT,7X,1HN,3X,1HJ]
      IA=2
  391 GO TO [360,392],IA
  392 L=1
C
C     COMPUTE VALUES FOR MOMENT AND CURVATURE EQUATIONS
C
  400 P[6]=R[7]-R[1]
      P[7]=R[7]+R[10]
      P[8]=R[7]-R[10]
      P[9]=R[7]+R[11]
```

```
C
  440 P[10]=R[7]-R[11]
      P[11]=P[7]*P[2]
      P[12]=P[8]*P[2]
      P[13]=P[9]*Q[3]
      P[14]=P[13]*Q[3]
      P[15]=0.5*Q[2]
      P[16]=P[15]*Q[4]*P[7]*P[7]
      P[17]=P[15]*Q[4]*P[8]*P[8]
      P[18]=4.*P[15]*R[7]*R[10]*Q[4]
C
C     COMPUTE CURVATURES FI[N] AND MOMENTS CM[M]
C     J=1 TO 10 IS FOR NEG. BENDING
C     J=11 TO 16 IS FOR POS. BENDING
C
      RPL=R[7]+CRS
      FIX1=Q[4]*ABSF[P[8]]
      IF[N-100]550,550,1070
  550 IF[ABSF[RPL]-RMAX]560,560,790
  560 IF[ABSF[R[7]]-P[10]]570,570,870
  570 IF[RPL-1.]580,580,700
  580 J=1
      V=P[6]
  600 FI[N]=V
  610 IF[ABSF[FI[N]]-FIX1]620,620,630
  620 GO TO [1430,2070,1430,2070,1430,2070,1430,2070,1430,2070],J
  630 GO TO [640,1430,750,1430,830,1430,950,1430,1030,1430],J
  640 J=2
      V=P[6]-P[12]
      W=P[17]
  670 IF[V]2070,2070,680
  680 FI[N]=-W/V
      GO TO 610
  700 J=3
  710 R[15]=1.2*RPL**0.6-0.65*RPL**0.2+0.45*RPL**[-0.2]
  711 R[15]=R[15]-CRS
  715 P[19]=[R[15]-P[7]]*Q[3]*Q[4]
      IF[J-4]730,730,1220
  730 V=P[6]+P[19]/Q[4]
  740 IF[V]600,600,2070
  750 J=4
      V=V-P[12]
      W=P[17]
      GO TO 670
  790 P[30]=CRS*Q[3]
      IF[ABSF[RPL]-P[10]]800,990,990
  800 J=5
      V=P[6]-P[13]-P[30]
      GO TO 740
  830 J=6
      V=V-P[12]
      W=P[17]
      GO TO 670
  870 J=7
      V=P[6]
      W=-P[16]
```

```
C
  900 IF(W)910,600,910
  910 T=V*V+4.*W
      IF(T)2070,930,930
  930 FI(N)=0.5*(V+SQRTF(T))
      GO TO 610
  950 J=8
      W=-P(18)
      V=P(6)-P(12)
      GO TO 670
  990 J=9
      V=P(6)-P(13)-P(30)
      W=-P(16)
      IF(V)900,2070,2070
 1030 J=10
      V=V-P(12)
      W=-P(18)
 1060 GO TO 670
 1070 J=13
      FIX2=Q(4)*P(7)
      IF(RP_-RMAX)1080,1080,1077
 1077 R(15)=R(12)-CRS
      GO TO 715
 1080 IF(RP_-1.)1090,1090,710
 1090 J=11
      V=P(6)
 1110 FI(N)=V
 1120 K=J-10
      IF(-FIX1-FI(N))1130,1130,700
 1130 IF(FI(N)-FIX2)1140,1140,1150
 1140 GO TO (1437,2140,1437,2140,1437,2140),K
 1150 GO TO (1160,1437,1260,1437,1390,1437),K
 1160 J=12
      V=P(6)-P(11)
      W=P(15)
 1190 IF(V)1200,2140,2140
 1200 FI(N)=-W/V
      GO TO 1120
 1220 IF(R(7)-R(10))1240,1240,1300
 1240 V=P(6)+P(19)/Q(4)
      GO TO 1110
 1260 J=14
      V=V-P(11)
      W=P(16)
      GO TO 1190
 1300 J=15
      V=P(6)+P(19)/Q(4)
      W=-P(17)
      IF(V)2140,1340,1340
 1340 IF(W)1350,1110,1350
 1350 T=V*V+4.*W
      IF(T)2140,1370,1370
 1370 FI(N)=0.5*(V+SQRTF(T))
      GO TO 1120
 1390 J=16
      V=V-P(11)
```

A 7

```
      W=P[18]
      GO TO 1101
 1430 IF[N-10]1432,1540,1432
 1432 IF[L-5]1435,1540,1540
 1435 DEFA=FI[N+1]-FI[N]
      GO TO 1438
 1437 DEFA=FI[N]-FI[N-1]
 1438 IF[N-10]1440,1540,1440
 1440 IF[DEFA-HS]1441,1540,1460
 1441 IF[J-10]2070,2070,2140
 1460 IF[DEFA-0.4]1540,1540,1470
 1470 IF[J-10]1500,1500,1520
 1500 R[7]=R[7]+0.3*P[8]
      GO TO 1530
 1520 R[7]=R[7]-0.3*R[8]
 1530 L=L+1
      IF[L-3]400,400,1540
 1540 R[13]=R[7]-FI[N]/Q[4]
      P[20]=Q[4]*[R[13]-R[7]]*Q[3]
      IF[RPL-RMAX]1555,1555,1552
 1552 R[15]=R[12]-CRS
 1555 P[24]=Q[4]*Q[3]*[R[15]-R[13]]
      P[21]=0.5*[1./3.-Q[4]]*[R[13]-R[7]]*Q[2]
      IF[FI[N]]1600,1580,1600
 1580 CM[N]=0.
      GO TO 2220
 1600 IF[J-10]1610,1610,1860
 1610 Q[6]=Q[4]*P[7]/FI[N]
      Q[8]=1.-Q[4]*P[8]/FI[N]
      P[22]=[R[13]-R[10]]*[P[3]*Q[1]+Q[8]*[P[3]-Q[8]/3.]*P[15]]
      P[23]=Q[6]*P[15]*P[7]*[Q[4]-Q[6]/3.]
      P[27]=[R[13]+R[11]]*Q[3]*Q[4]
      GO TO [1660,1680,1700,1720,1740,1760,1780,1800,1820,1840],J
C
C     NEGATIVE MOMENT EQUATIONS
C
 1660 CM[N]=[-P[20]+P[21]]/Q[5]
      GO TO 2220
 1680 CM[N]=[-P[20]+P[21]+P[22]]/Q[5]
      GO TO 2220
 1700 CM[N]=[P[24]+P[21]]/Q[5]
      GO TO 2220
 1720 CM[N]=[P[24]+P[21]+P[22]]/Q[5]
      GO TO 2220
 1740 CM[N]=[-P[27]+P[21]+P[30]]/Q[5]
      GO TO 2220
 1760 CM[N]=[-P[27]+P[21]+P[22]+P[30]]/Q[5]
      GO TO 2220
 1780 CM[N]=[-P[20]+P[21]-P[23]]/Q[5]
      GO TO 2220
 1800 CM[N]=[-P[20]+P[21]-P[23]+P[22]]/Q[5]
      GO TO 2220
 1820 CM[N]=[-P[27]+P[21]-P[23]+P[30]]/Q[5]
      GO TO 2220
 1840 CM[N]=[-P[27]+P[21]+P[22]-P[23]+P[30]]/Q[5]
```

```
      GO TO 2220
 1860 Q[7]=Q[4]*P[8]/FI[N]
      Q[9]=1.-Q[4]*P[7]/FI[N]
      P[25]=[R[13]+R[10]]*[P[3]*Q[1]+Q[9]*[P[3]-Q[9]/3.]*P[15]]
      P[26]=Q[7]*P[15]*P[8]*[Q[4]-Q[7]/3.]
      GO TO [1920,1940,1960,1980,2000,2020],K
C
C     POSITIVE MOMENT EQUATIONS
C
 1920 CM[N]=[-P[20]+P[21]]/Q[5]
      GO TO 2220
 1940 CM[N]=[-P[20]+P[21]+P[25]]/Q[5]
      GO TO 2220
 1960 CM[N]=[P[24]+P[21]]/Q[5]
      GO TO 2220
 1980 CM[N]=[P[24]+P[21]+P[25]]/Q[5]
      GO TO 2220
 2000 CM[N]=[P[24]+P[21]-P[26]]/Q[5]
      GO TO 2220
 2020 CM[N]=[P[24]+P[21]+P[25]-P[26]]/Q[5]
      GO TO 2220
 2030 N=N-1
      IF[N]2110,2110,2070
 2042 IF[0.99-CM[N+1]/CMX2]2080,2080,2050
 2050 LL=1
 2051 RPL=R[7]+CRS
      IF[RPL-1.]2053,2053,2067
 2053 PSX3=R[7]
 2054 IF[PSX3-PSX2]2060,2060,2055
 2055 FST=R[1]-PSX3*Q[3]
      IF[FST/P[2]-R[10]]301,2270,2270
 2060 GO TO [2061,2064],IA
 2061 R[7]=R[7]+R[8]
      GO TO 2051
 2064 P[7]=R[7]+0.1*R[8]
      LL=LL+1
      IF[LL-10]2051,2051,3001
 2067 PSX3=1.2*RPL**0.6-0.65*RPL**0.2+0.45*RPL**[-0.2]
      PSX3=PSX3-CRS
      GO TO 2054
 2070 R[7]=R[7]-R[8]
      GO TO 2042
 2080 FI[N]=FI[N+1]-1.
      CM[N]=[CMX2-CM[N+1]]*[FI[N]-FI[N+1]]/[-500.-FI[N+1]]+CM[N+1]
      GO TO 2220
 2110 N=100
      R[7]=RIN
 2130 N=N+1
      IF[N-200]2140,2140,2241
 2140 R[7]=R[7]+R[8]
      IF[0.99-CM[N-1]/CMX1]2152,2152,2160
 2152 FI[N]=FI[N-1]+1.
      CM[N]=[CMX1-CM[N-1]]*[FI[N]-FI[N-1]]/[500.-FI[N-1]]+CM[N-1]
      GO TO 2220
 2160 IF[PNT1]2161,2161,301
```

```
C
 2161 LL=1
 2180 RPL=R(7)+CRS
      IF(RPL-1.)2182,2182,2187
 2182 PSX3=R(7)
 2183 IF(PSX1-PSX3)2184,2184,391
 2184 R(7)=R(7)-0.1*R(8)
      LL=LL+1
      IF(LL-10)2180,2180,3001
 3001 PRINT 3002
 3002 FORMAT(1X,27HEXIT CALLED. LL EXCEEDS 10.    )
      GO TO 2270
 2187 PSX3=1.2*RPL**0.6-0.65*RPL**0.2+0.45*RPL**(-0.2)
      PSX3=PSX3-CRS
      GO TO 2183
 2220 PRINT 2230,R(7),FI(N),CM(N),N,J
 2230 FORMAT(36X,F9.3,2(4X,F11.6),3X,I3,2X,I2)
C
C     IF FOR N GREATER THAN 100 THE MOMENT IS NEAR THE MAXIMUM NEGATIVE
C     MOMENT,CMX2,USE A LOWER STRAIN INCREMENT (R(8)) SO THAT MORE
C     VALUES OF POSITIVE BENDING CAN BE COMPUTED.
C
      IF(N-100)2030,2030,2231
 2231 IF(CM(N)-0.85*CMX2)2232,2233,2233
 2232 R(8)=R8A
      GO TO 2130
 2233 R(8)=R8
      GO TO 2130
 2241 CALL INTEG
 2270 CONTINUE
 2280 II=II+1
      IF(II-NN)10,10,3000
 3000 CALL EXIT
      END
```

```
C     GIVEN A MOMENT-CURVATURE RELATION FOR A SECTION,SUBROUTINE INTEG
C     WILL DETERMINE THE MAXIMUM FIXED AND PINNED LENGTHS THAT THE
C     SECTION CAN SUSTAIN UNDER A GIVEN AXIAL AND LATERAL LOADING PAIR
C
            SUBROUTINE INTEG
C
C     THE FOLLOWING QUANTITIES ARE PLACED IN COMMON SO THAT MORE STORAGE
C     SPACE IS LEFT AVAILABLE FOR THE COMPUTER PROGRAMS
C
            COMMON R(30),Q(10),P(30),FI(200),CM(200),LRUN,SUM,X(25),Y(30),RES
            COMMON B,QL1,QLIC,DSI,FIC,AST,AFS,CMX1,CMX2,PSI1
            COMMON NN,NRUN,R4N,R4I,NR4,R5N,R5I,NR5,ASTN,ASTI,NAST,AFSN,AFSI
            COMMON NAFS,RFSN,RFSI,NRFS,RN,RI,NBB,R1N,R1I,NR1,    PMAX,PSX1,STFN
            COMMON PSX2,PPL,V,W,T,J,DEFA,LI,PSX3,RIN,L,ILI
            COMMON C,INUM,REY,EY,CR,PHC,QIP,JA,IR,IC,I,IE
            COMMON DST,SN,CS,JB,C1,C2,C3,C4,C5,C11,PHC1,C13,C14,FMOM,CA,CC,CD
            COMMON TLEN,XLEN,EFIX,EPIN
            COMMON LT,IALLA,QL1A,QLICA,NSUMA,F1,RK,F2,F3,GH,FS,Z1,ZJ,ZK,ZL,ZM
            COMMON FOI,DSII,FII,LS,IAFLL,QFL1,QFLIC,NFSUM
       90   PRINT 100
      100   FORMAT(1H1,44X,32H***MAXIMUM SLENDERNESS RATIOS***///)
            PRINT 130,LRUN
      130   FORMAT(52X,11HRUN NUMBER ,I5,//)
C
C     THE FOLLOWING LOOP IS TO CONVERT MOMENTS AND CURVATURES TO A FORM
C     THAT THEY ARE NON-DIMENSIONALIZED BY DIVISION BY PLATE YIELD
C     VALUES RATHER THAN CRITICAL BUCKLING VALUES
C
            DO 1 I=1,200
            CM(I)=CM(I)/R(11)
        1   FI(I)=FI(I)/R(11)
            CMX2=CMX2/R(11)
            CMX1=CMX1/R(11)
C
C     MATERIAL PROPERTIES
C
            EY=R(5)/R(6)
            REY=SQRTF(EY)
C
C     SECTION PROPERTIES
C     CR=R/V WHERE R IS THE RADIUS OF GYRATION AND V IS THE DISTANCE
C     FROM THE PLATE TO THE ELASTIC NEUTRAL AXIS
C
            CR=SQRTF((1.-2.*Q(4))*Q(1)+(1./3.-Q(4))*Q(2)+Q(4)*Q(4))/Q(4)
C
C
C     QLL IS THE LATERAL LOAD (P.S.I.)
C     II IS A COUNTER OF LATERAL LOADS
C
            LS=LT
            IAFLL=IALL
            QFL1=QL1
            QFLIC=QLIC
            NFSUM=NSUM
            PRINT 120,DSI,FIC
```

```
  120 FORMAT(30X,13H*INPUT*        ,4HDSI=,F8.6,5X,4HFIC=,F8.6,/////)
      C=0.001*Q(4)*Q(3)/(EY*R(5))
  285 QLL=Q.1-QLIC
      II=1
 5010 QLL=QLL+QLIC
C
C     SUBROUTINE VALUES ADJUSTS THE INCREMENTS OF SEGMENT LENGTH AND
C     MID-HEIGHT CURVATURE FOR THE CROSS-SECTION BEING RUN
C
      CALL VALUES (QLL,FICA,DSIA)
      FOI=FIC*FICA
      DSII=DSI*DSIA
      FII=FOI/R(11)
C
C     ESTIMATE INITIAL MID-HEIGHT CURVATURE PHC
C
      PHC=CJR(QLL)
      PHC1=PHC*R(11)
      EPIN=0.
      EFIX=0.
C
      INUM=II+IA(I)-1
      QIR=QLL*C
      JA=20
      PRINT 5086,IRUN,INUM,QLL,QIR,PHC1,DSII,FOI
 5086 FORMAT(12X,11HCASE NUMBER ,I5,1H.,I2,4X,4HQLI =,F9.4,4X,4HQIR=,F8.
     1,4X,5HPHCI=,F6.4 ,4X,5HDSII=,F6.4,4X,4HFOI=,F6.4)
      PRINT 5100
 5100 FORMAT(//8X,4HCURV,12X,3HL/R,11X,3HX/R,12X,3HY/R,12X,3HMOM,11X,5HS
     1LOPE,12X,1HP,10X,4HENDS)
C
C     INITIALIZE THE VALUES
C
 5110 DO 5120 K=1,30
 5120 Y(K)=0.
      IA=1
      IB=2
      IC=1
 5160 DO 5170 K=1,16
 5170 X(K)=0.
      ID=1
      IE=1
      X(17)=R(1)/R(11)
      X(19)=DSII
      DST=DSII
      SN=0.
      CS=1.
      N=99
 5260 N=N+1
      IF(200-N)5275,5270,5270
 5275 PRINT 5276
 5276 FORMAT(1X,42HCURVATURE OUTSIDE LIMITS OF M-PHI-P CURVE    )
      GO TO 648)
C
C     CHOOSING A CURVATURE THAT MATCHES THE COMPUTED ONE
```

```
5270 IF(FI(N)-PHC)5260,5280,5280
5280 F=(FI(N)-PHC)/(FI(N)-FI(N-1))
     X(11)=CM(N)-F*(CM(N)-CM(N-1))
     IF(X(11))5310,5310,5321
5310 PHC=PHC+0.05
     GO TO 5270
5321 X(23)=PHC
     JB=36
5323 JB=JB-1
C
     IF(JB)5325,5330,5330
5325 Y(4)=1.
     PRINT 5326
5326 FORMAT(36H ERROR**TOO MANY LENGTH INCREMENTS    )
     GO TO 6163
5330 I=1
     X(20)=DST
C
C    FOR A FIRST GUESS ASSUME THAT THE CURVATURE AT THE TERMINAL END IS
C    THE SAME AS THE CURVATURE AT THE INITIAL END.
C
     X(25)=X(23)
C
C    CALCULATE THE VALUES OF THE FORCES AT THE INITIAL END AND CHORD
C    LENGTH,CENTER DEFLECTION, AND MOMENT AT THE TERMINAL END.
C
5333 C1=(X(23)/3.+X(25)/6.)*CR*X(20)
     C2=(CS-C1*REY*SN)*X(20)
     C3=(SN/REY+C1*CS)*X(20)
     C13=X(15)
     C14=X(17)
     X(12)=X(11)-(C2*(C13+QIR*0.5*C2)+C3*(C14/CR+C3*EV*0.5*QIR))
C
     TLEN=C2
     YLEN=C3
C
C    EVALUATE THE CURVATURE CORRESPONDING TO THE CALCULATED MOMENT BY
C    USING A LINEAR INTERPOLATION
C
5400 N=N+1
     IF(200-N)5520,5420,5420
5420 IF(CM(N)-X(12))5400,5430,5430
5430 IF(X(12)-CM(N-1))5440,5590,5590
5440 N=N-1
     IF(N-1)5460,5460,5430
5460 C1=X(12)-CMX2
     IF(C1)5490,5490,5480
C
5480 GO TO (5560,5620),ID
5490 C1=X(11)-CMX2
     X(20)=0.5*X(20)+C1/(X(11)-X(12))
     GO TO 5571
5520 C1=CM(200)-X(11)
     N=199
```

```
      X(20)=0.2*X(20)+C1/(X(12)-X(11))
      GO TO 5570
 5560 X(20)=0.1*X(20)
 5570 I=I+1
      IF(I-15)5333,5333,5700
 5590 F=(CM(N)-X(12))/(CM(N)-CM(N-1))
      X(24)=FI(N)-F*(FI(N)-FI(N-1))
      GO TO 5650
 5620 C4=(CM(1)-CMX2)/C1
      C5=C4*C1/(CM(2)-CM(1))
      X(24)=(C4+1.)*FI(1)-SQRTF(FI(1)*FI(1)-FI(2))*C5
C
C     CHECK THE CONVERGENCE OF THE ASSUMED AND CALCULATED CURVATURES.
C     IF THEY ARE VERY CLOSE CONTINUE ON,IF NOT,RECALCULATE THE VALUES
C
 5650 IF(ABSF(1.-X(25)/X(24))-0.00001)5700,5660,5660
 5660 I=I+1
      IF(I-15)5680,5680,5700
 5680 X(25)=X(24)
      GO TO 5333
C
C     COMPUTE THE SLOPE AT THE TERMINAL POINT AND USE THIS TO COMPUTE
C     THE OTHER TERMINAL VALUES
C
 5700 C1=X(23)+X(24)
      X(14)=X(13)+0.5*C1*X(20)*CR*REY
      SN=SINF(X(14))
      CS=COSF(X(14))
      EMOM=SN-SINF(X(13))
      F=CS-COSF(X(13))
      X(16)=C13+OIR*(C2-REY*EMOM/CR)
      X(18)=C14+OIR*FY*(C3*CR+F)
      X(9)=X(8)+C3
      X(6)=X(5)+2.*C2
      X(3)=X(2)+2.*X(20)
      C5=X(24)-X(23)
      CA=X(19)
      CB=X(20)
      GO TO (5830,6010),IE
 5830 IF(X(12))5840,6010,6010
C
C     COMPUTE THE VALUES FOR THE PINNED CASE. FUNCTION BC CALCULATES
C     THE SEGMENT LENGTH CORRESPONDING TO ZERO MOMENT BY NEWTONS METHOD
C     THE PANEL LENGTH, CHORD LENGTH, CENTER DEFLECTION, AND SLOPE ARE
C     INTERPOLATED LINEARLY.
C
 5840 C1=(X(12)-X(11))*X(19)
      C2=(X(10)-X(11))*X(20)
      C4=(X(19)+X(20))*X(19)*X(20)
      C3=(C1+C2)/C4
      C4=(C1*X(19)-C2*X(20))/C4
 5890 C1=BC(C3,C4,X(11),0.)
      X(29)=X(13)+(X(23)+0.5*C5*C1/X(20))*C1*CR*REY
      X(23)=0.
      IE=2
```

```
C
      ID=2
      IF(CMX1+C4X2)5950,5940,5940
 5940 DST=0.4*DST1
 5950 Y(5)=X(2)+2.*C1
      Y(11)=X(5)+C1*2.*TLEN/CB
      Y(17)=X(8)+C1*XLEN/CB
 6010 IF(X(14))6020,6170,6170
C
C     COMPUTE THE VALUES FOR THE FIXED END CASE
C     FUNCTION BC COMPUTES THE SEGMENT LENGTH CORRESPONDING TO ZERO
C     SLOPE BY NEWTON-S METHOD. THE PANEL LENGTH, CHORD LENGTH, AND
C     CENTER DEFLECTION ARE INTERPOLATED LINEARLY. THE END MOMENT IS
C     COMPUTED BY A PARABOLIC EQUATION IN FUNCTION VAL.
C
 6020 C1=0.5*C5*REY*CB/X(20)
      C2=X(23)*REY*CB
      C1=BC(C1,C2,X(13),0.)
      Y(30)=0.
      Y(6)=X(2)+2.*C1
      Y(12)=X(5)+C1*2.*TLEN/CB
      Y(18)=X(8)+C1*XLEN/CB
      Y(24)=VAL(X(10),X(11),X(12),C1,CA,CB)
 6163 GO TO (6230,6430),IA
C
C     LET THE TERMINAL VALUES OF THE SEGMENT JUST COMPLETED BECOME INIT-
C     IAL VALUES FOR THE NEW SEGMENT. USING THE NEW INITIAL VALUES, GO
C     BACK AND CALCULATE THE VALUES FOR THE NEXT SEGMENT.
C
 6170 DO 6180 I=1,23
      X(22)=0.
 6180 Y(I)=X(I+1)
      I=1
      GO TO 5323
C
 6230 IF(Y(5)-Y(4))6250,6240,6240
 6240 GO TO (6430,6510),IC
 6250 IA=2
      IB=IB-1
      K=6
C
C     COMPUTE THE ULTIMATE CONDITIONS AS DEFINED BY ZERO SLOPE IN THE
C     PANEL LENGTH-DEFLECTION CURVE AND PRINT OUT THE RESULTS
C
C
C     FIND THE MAXIMUM LENGTH Y(K) AND THE CHANGE IN CURVATURE C(3) FROM
C     THE PREVIOUS POINT THAT CORRESPONDS TO THIS LENGTH. USE A PARABOL-
C     IC APPROXIMATION
C
 6280 C1=Y(K)-Y(K-4)
      C2=Y(K)-2.*Y(K-2)+Y(K-4)
      C3=-0.5*FII*C1/C2
      CA=FII
      CB=FII
      Y(K)=Y(K-2)-0.125*C1*C1/C2
      IF(Y(K-4)-0.00001)6335,6335,6340
```

```
 6335 IF(IR-2)6338,6338,6336
 6336 PRINT 6337
 6337 FORMAT(40H ERROR**FIXED END**INITIAL PHC TOO HIGH     )
      GO TO 6340
 6338 PRINT 6339
 6339 FORMAT(39H ERROR**S.S. END**INITIAL PHC TOO HIGH     )
C
C     FIND THE VALUES OF CHORD LENGTH, CENTER DEFLECTION, MOMENT, AND
C     SLOPE RESPECTIVELY THAT CORRESPOND TO THE POINT OF MAXIMUM MOMENT.
C     USE A PARABOLIC APPROXIMATION.
C
 6340 K=K+6
 6352 Y(K)=VAL(Y(K-4),Y(K-2),Y(K),C3,CA,CB)
      K=K+6
      IF(K-31)6352,6360,6360
C
C     FIND THE MID-HEIGHT CURVATURE (CC) AND AXIAL FORCE (CD) THAT
C     CORRESPOND TO THE ULTIMATE CONDITION. BOTH ARE NON-DIMENSIONALIZED
C     BY THE CRITICAL VALUES.
C
 6360 CC=(PHC-FI(I+C3))*R(11)
 6370 CD=R(1)+O(R*FY*P(3)/O(4)*(Y(K-18)+(COSF(Y(K-6))-1.)/CB)
C
C
C     PRINT ANSWERS FOR F.E. AND P.E.
C     CURV.,MOM. AND P HAVE BEEN NON-DIMENSIONALIZED BY DIVISION BY THE
C     CORRESPONDING PLATE CRITICAL VALUES. THE SLOPE IS IN DIMENSIONAL
C     FORM. L/R,X/R AND Y/R HAVE NOT BEEN FURTHUR NON-DIMENSIONALIZED.
C     CURV. AND Y/R ARE CURVATURE AND DEFLECTION AT MID-HEIGHT RESP..
C     X/R REFERS TO THE CHORD LENGTH, AND L/R TO THE TOTAL LENGTH OF THE
C     PANEL. MOMENT AND SLOPE REFER TO THE END VALUES.
C
      TLEN    =Y(K-30)/REY
      XLEN    =Y(K-24)/REY
      FMOM=Y(K-12)*R(11)
      IF(Y(K-6)-0.000001)6396,6396,6398
 6396 FFIX=TLEN
      PRINT 6397,CC,FFIX,XLEN,Y(K-18),FMOM,Y(K-6),CD
 6397 FORMAT(7(5X,F10.6),4X,5HFIXED,//)
      GO TO 6420
 6398 FPIN=TLEN
      PRINT 6399,CC,FPIN,XLEN,Y(K-18),FMOM,Y(K-6),CD
 6399 FORMAT(7(5X,F10.6),5X,4HS.S.,/////)
C
 6420 GO TO (6430,6480),IR
 6430 IF(Y(5)-Y(3))6440,6510,6510
 6440 K=5
      IR=IR+1
      IF(IR-2)6460,6460,6451
 6451 PRINT 6452
 6452 FORMAT(21H ERROR**IR EXCEEDS 2    )
 6460 IC=2
      GO TO 6280
 6480 PUNCH 6481,IRUN,INUM,EFIX,FPIN,R(1),AST,AFS,R,REC,R(5),R(4),R(6),O
     1LL
```

```
 6461 FORMAT(I5,I2,2F6.2,F4.2,2F6.5,F5.1,F5.4,2F5.1,F7.1,F5.1)
C
C     CHECK TO SEE IF THE MAXIMUM LATERAL LOAD CASE HAS BEEN RUN, AND
C     ALSO IF ADDITIONAL LATERAL LOADS ARE TO BE RUN
C
      II=II+1
      IF(II-NSUM)5010,5010,6490
 6490 LS=LS+1
      IF(LS-2)3000,6491,6580
 6491 IALL=IALFA
      OL1=OL1A
      OLIC=OLICA
      NSUM=NSUMA
      GO TO 285
C
 6510 JA=JA-1
      IF(JA)6521,6530,6530
 6521 PRINT 6522
 6522 FORMAT(4X,48HTOO MANY PHC VALUES REQUIRED, USE A LARGER FIC.     1
      GO TO 6480
C
C     INITIALIZE THE VALUES. CHOOSE A NEW CENTER CURVATURE AND BEGIN
C     CALCULATIONS TO AGAIN FIND THE CORRESPONDING PINNED AND FIXED
C     LENGTHS.
C
 6530 PHC=PHC+FII
      DO 6560 K=1,27,2
      Y(K)=Y(K+2)
 6560 Y(K+1)=Y(K+3)
      GO TO 5160
C
 6580 IALL=IAFLL
      OL1=OFL1
      OLIC=OFLIC
      NSUM=NFSUM
 3000 RETURN
      END
```

SUBROUTINE VALUES


```
      SUBROUTINE VALUES (QLL,FICA,DSIA)
      COMMON R(20),Q(10),P(30),FI(200),CM(200),LRUN,NSUM,X(25),Y(30),RES
      COMMON B,QII,QLIC,DSI,FIC,AST,AFS,CMX1,CMX2,PNT1
      COMMON NN,NRUN,R4N,R4I,NR4,R5N,R5I,NR5,ASTN,ASTI,NAST,AFSN,AFSI
      COMMON NAFS,RESN,RESI,NRES,RN,RI,NRR,R1N,R1I,NR1,   RMAX,PSX1,STEN
      COMMON PSX2,RPL,V,W,T,J,DEFA,LI,PSX3,RIN,L,TALI
      COMMON C,INUM,REY,EY,CP,PHC,QIR,JA,IB,IC,ID,IE
      COMMON DST,SN,CS,JR,C1,C2,C3,C4,C5,C11,PHC1,C13,C14,FMOM,CA,CC,CD
      COMMON TLEN,XLEN,FFIX,FPIN
      COMMON IT,TALLA,QL1A,QLICA,NSUMA,F1,RK,F2,F3,GH,FS,ZI,ZJ,ZK,ZL,ZM
      FS=.0000106*QLL*QLL-0.007*QLL+1.9
      ZJ=1.+0.0165*(R(4)-50.)
      ZK=1.+0.01*(B-85.)
      ZN=0.0086*R(4)+0.6
      ZL=1.+0.02*(B-85.)
      ZM=1.+2.5*(AST-.35)
      SP=0.014*3*(0.0086*R(4)+0.66)
      IF(R(1)-SP)5,5,6
    5 ZI=1.
      GO TO 7
    6 ZI=1.-(R(1)-SP)/(0.016*B-.36)
    7 DSIA=FS*ZI*ZN*ZK*REY/0.04
      FICA=ZI*ZL*ZM*ZJ
      RETURN
      END
```

FUNCTION CUR

```
C
C     FUNCTION CUR PROVIDES AN ESTIMATE OF THE INITIAL MID-HEIGHT CURV.
C
      FUNCTION CUR(OLI)
      COMMON H(20),O(10),P(30),FI(200),CM(200),LRUN,NSUM,X(25),Y(30),RFS
      COMMON B,QI1,OLIC,DSI,FIC,AST,AFS,CMX1,CMX2,PNT1
      COMMON NN,NRUN,R4N,R4I,NR4,R5N,R5I,NR5,ASTN,ASTI,NAST,AFSN,AFSI
      COMMON NAFS,RFSN,RFSI,NRFS,RN,RI,NRB,R1N,R1I,NR1,    RMAX,PSX1,STFN
      COMMON PSX2,RPL,V,W,T,J,DEFA,LL,PSX3,RIN,L,IALI
      COMMON C,INUM,REY,FY,CR,PHC,OIR,A,IR,IC,ID,IE
      COMMON DST,SN,CS,JR,C1,C2,C3,C4,C5,C11,PHC1,C13,C14,FMOM,CA,CC,CD
      COMMON TLEN,XLEN,FFIX,FPIN
      COMMON LT,IALLA,OL1A,QLICA,NSUMA,F1,RK,F2,F3,GH,FS,Z1,Z
      RK=B/75.-0.30*RFS*R(1)
      IF(R(1)-RK)63,63,64
   63 F1=1.
      GO TO 65
   64 F1=1.0-((R(1)-RK)/(0.0175*B-0.575))
      IF(F1)69,69,65
   69 F1=0.1
   65 IF(R(1)-1.)66,66,67
   66 F2=1.+7.0*(AST-0.15)*(1.-R(1))
      F3=R(1)
      GO TO 68
   67 F2=1.0
      F3=1.0
   68 CUR=0.00004*B*B*F1*F2*(1.+F3*(OLI-160.)/400.)*(1.04-1.3*AST*REY*(
     11.00107*OLI)*(0.0075*R(4)+0.65))/R(1)
      RETURN
      END
```

SUBROUTINE PARAM

```
      SUBROUTINE PARAM(HS,R8A,R8)
      COMMON R(20),O(10),P(30),F(200),CN(200),LRUN,NSUM,X(25),Y(30),RFS
      COMMON B,OL1,OLTC,DST,FIC,AST,AFS,CMY1,CMX2,PNT1
      COMMON NN,NRUN,R4N,R4I,NR4,R5N,R5I,NR5,ASTN,ASTI,NAST,AFSN,AFSI
      COMMON NAFS,RFSN,RFSI,NRES,RN,RI,NRB,R1N,R1I,NR1,   RMAX,PSX1,STFN
      COMMON PSX2,RPL,V,W,T,J,DEFA,LI,PSX3,RIN,L,IALL
      COMMON C,INUM,REY,FY,CP,PHC,OIR,JA,IR,IC,ID,IE
      COMMON DST,SN,CS,JR,C1,C2,C3,C4,C5,C11,PHC1,C13,C14,FMOM,CA,CC,CD
      COMMON TLEN,XLEN,FFIX,FPIN
      COMMON LT,IALLA,OL1A,OLICA,NSUMA,F1,RK,F2,F3,GH,FS,ZI,ZJ,ZK,ZL,ZM
      GH=(-0.0016*B*B+.125*B-5.)*(1.7*AST+.5)
      IF(GH-.65)1,3,3
    3 HS=0.02*GH
      R8A=1.5*R(8)*GH
      R8=R(8)*GH
      GO TO 2
    1 HS=0.013
      R8=.65*R(8)
      R8A=R(8)
    2 RETURN
      END
```

FUNCTION VAL

```
C     FUNCTION VAL CALCULATES A VALUE USING THE EQUATION OF A PARABOLA
C     VAL=((VAL3-VAL2)CA+(VAL1-VAL2)CB)(D)(D)/((CA)(CB)(CA+CB))+((VAL3
C     -VAL2)(CA)(CA)-(VAL1-VAL2)(CB)(CB))(D)/((CA)(CB)(CA+CB))+VAL2
C
      FUNCTION VAL(VAL1,VAL2,VAL3,VAL4,CA,CB)
      C14=(VAL3-VAL2)*CA
      C13=CA*CB*(CA+CB)
      C12=(VAL1-VAL2)*CB
      C11=(C14-C12)/C13
      C12=(C11*CA-C12*CB)/C13
      VAL=C11*VAL4*VAL4+C12*VAL4+VAL2
      RETURN
      END
```

FUNCTION BC

```
C
C     BY USING NEWTON-S METHOD, FUNCTION BC FINDS THE ZERO ROOT OF A
C     PARABOLIC EQUATION SIMILAR TO THAT USED IN FUNCTION VAL
C
      FUNCTION BC(BC1,BC2,BC3,BC4)
      C3=BC3
      C4=BC4
      KK=15
 8140 C3=BC1*C4*C4+BC2*C4+BC3
      C4=C4-C3/(2.*BC1*C4+BC2)
      KK=KK-1
      IF(KK)8190,8180,8180
 8180 IF(ABSF(C3)-0.0000001)8190,8190,8140
 8190 BC=C4
      RETURN
      END
```

EXAMPLE RUN

RUN NUMBER 77

AST=0.340000 AFS=0.600000 B/T=110.000 AF=0.152239 AW=0.101493

MAX LOAD= 3.190880 STIFF YIELD= 5.314463 PLATE YIELD= 5.314463

PSX1= 2.879400 CMX1= 1.468456 PNT1= 0.738898

AXIAL LOAD= 1.300 PLATE RESID. STRESS=0.075 C/B=0.070

MOD. OF ELASTICITY=29600.0 PLATE YIELD STRESS= 47.000

AP=0.746269 CT=0.202985 SM=0.713682

MAX PL STRS= 2.879400 MAX PL STRN= 5.931998

PSX2=-0.064917 CMX2=-1.141792

Cont.

STRAIN INCREMENT= 0.003

STIFF. YIELD STRESS= 47.000

STRAIN	CURVATURE	MOMENT	N	J
1.300	-0.274203	-0.352192	100	3
1.201	-0.332786	-0.399280	99	3
1.102	-0.391853	-0.446988	98	3
1.003	-0.451423	-0.495344	97	3
0.907	-0.509687	-0.542875	96	3
0.811	-0.568459	-0.591058	95	3
0.715	-0.627751	-0.639910	94	3
0.619	-0.687570	-0.689430	93	3
0.553	-0.747000	-0.747000	92	1
0.493	-0.807000	-0.807000	91	1
0.433	-0.867000	-0.867000	90	1
0.373	-0.927000	-0.927000	89	1
0.313	-0.987000	-0.987000	88	1
0.268	-1.055871	-1.029216	87	2
0.250	-1.124199	-1.041418	86	2
0.235	-1.187428	-1.051021	85	2
0.220	-1.257335	-1.060115	84	2
0.208	-1.318810	-1.067026	83	2
0.196	-1.385956	-1.073617	82	2
0.184	-1.450591	-1.079889	81	2
0.175	-1.510662	-1.084385	80	2

CONT.

0.[illegible]66	-1.[illegible]	-1.[illegible]	[illegible]	[illegible]
0.[illegible]57	-1.65[illegible]	-1.[illegible]	[illegible]	2
0.148	-1.730409	-1.096815	77	2
0.139	-1.813082	-1.100609	76	2
0.133	-1.872380	-1.103042	75	2
0.127	-1.935392	-1.105398	74	2
0.121	-2.002476	-1.107677	73	2
0.115	-2.074040	-1.109881	72	2
0.109	-2.150547	-1.112008	71	2
0.103	-2.232528	-1.114060	70	2
0.097	-2.320591	-1.116036	69	2
0.091	-2.415437	-1.117937	68	2
0.085	-2.517883	-1.119763	67	2
0.079	-2.628877	-1.121514	66	2
0.076	-2.687921	-1.122362	65	2
0.073	-2.749556	-1.123191	64	2
0.070	-2.813892	-1.124001	63	2
0.067	-2.881178	-1.124794	62	2
0.064	-2.951597	-1.125567	61	2
0.061	-3.025373	-1.126322	60	2
0.058	-3.102753	-1.127059	59	2
0.055	-3.184087	-1.127778	58	2
0.052	-3.269432	-1.128478	57	2
0.049	-3.359360	-1.129159	56	2
0.046	-3.454153	-1.129823	55	2
0.043	-3.554220	-1.130468	54	2
0.040	-4.554220	-1.130491	53	2
0.037	-5.554220	-1.130514	52	2
0.034	-6.554220	-1.130536	51	2
0.031	-7.554220	-1.130559	50	2
0.028	-8.554220	-1.130582	49	2
0.025	-9.554220	-1.130605	48	2
0.022	-10.554220	-1.130628	47	2
0.019	-11.554220	-1.130650	46	2
0.016	-12.554220	-1.130673	45	2
0.013	-13.554220	-1.130696	44	2
0.010	-14.554220	-1.130719	43	2
0.007	-15.554220	-1.130742	42	2
0.004	-16.554220	-1.130764	41	2
0.001	-17.554220	-1.130787	40	2
-0.002	-18.554220	-1.130810	39	2
-0.005	-19.554220	-1.130833	38	2
-0.008	-20.554220	-1.130856	37	2
-0.011	-21.554220	-1.130879	36	2
-0.014	-22.554220	-1.130901	35	2
-0.017	-23.554220	-1.130924	34	2
-0.020	-24.554220	-1.130947	33	2
-0.023	-25.554220	-1.130970	32	2
-0.026	-26.554220	-1.130993	31	2
-0.029	-27.554220	-1.131015	30	2
-0.032	-28.554220	-1.131038	29	2
-0.035	-29.554220	-1.131061	28	2
-0.038	-30.554220	-1.131084	27	2
-0.041	-31.554220	-1.131107	26	2
-0.044	-32.554220	-1.131129	25	2
-0.047	-33.554220	-1.131152	24	2
-0.050	-34.554220	-1.131175	23	2
-0.053	-35.554220	-1.131198	22	2

A2[illegible]

[illegible]	[illegible]	[illegible]	21	[illegible]
-0.059	-37.554220	-1.131[illegible]44	20	2
-0.062	-38.554220	-1.131266	19	2
-0.065	-39.554220	-1.131289	18	2
-0.068	-40.554220	-1.131312	17	2
-0.071	-41.554220	-1.131335	16	2
-0.074	-42.554220	-1.131358	15	2
-0.077	-43.554220	-1.131380	14	2
-0.080	-44.554220	-1.131403	13	2
-0.083	-45.554220	-1.131426	12	2
-0.086	-46.554220	-1.131449	11	2
-0.089	-47.554220	-1.131472	10	2
-0.092	-48.554220	-1.131494	9	2
-0.095	-49.554220	-1.131517	8	2
-0.098	-50.554220	-1.131540	7	2
-0.101	-51.554220	-1.131563	6	2
-0.104	-52.554220	-1.131586	5	2
-0.107	-53.554220	-1.131608	4	2
-0.110	-54.554220	-1.131631	3	2
-0.113	-55.554220	-1.131654	2	2
-0.116	-56.554220	-1.131677	1	2
1.402	-0.214331	-0.304301	101	13
1.507	-0.153316	-0.255734	102	13
1.612	-0.092776	-0.207770	103	13
1.716	-0.032692	-0.160407	104	13
1.821	0.026957	-0.113595	105	13
1.926	0.086188	-0.067318	106	13
2.031	0.145021	-0.021555	107	13
2.135	0.203470	0.023717	108	13
2.249	0.256376	0.072228	109	13
2.362	0.328868	0.120209	110	13
2.476	0.390963	0.167680	111	13
2.590	0.452670	0.214663	112	13
2.703	0.514029	0.261177	113	13
2.817	0.575027	0.307239	114	13
2.930	0.635687	0.352867	115	13
3.044	0.696022	0.398076	116	13
3.157	0.756042	0.442882	117	13
3.271	0.815759	0.487298	118	13
3.384	0.875183	0.531338	119	13
3.498	0.934324	0.575015	120	13
3.611	0.993191	0.618339	121	13
3.725	1.051792	0.661322	122	13
3.838	1.110137	0.703976	123	13
3.960	1.172691	0.749552	124	13
4.083	1.234965	0.794770	125	13
4.205	1.296968	0.839630	126	13
4.327	1.358709	0.884171	127	13
4.449	1.420194	0.928375	128	13
4.572	1.481433	0.972262	129	13
4.694	1.542431	1.015840	130	13
4.816	1.603196	1.[illegible]110	131	13
4.938	1.663733	1.102106	132	13
5.061	1.724050	1.1[illegible]809	133	13
5.183	1.784152	1.[illegible]7236	134	13
5.305	1.844045	1.2[illegible]	135	13
5.427	1.903664	1.271[illegible]2	136	15
5.567	1.963550	1.3084[illegible]	137	15
5.803	2.022490	1.31707[illegible]	138	15
6.039	2.080937	1.32513[illegible]	139	15
6.283	2.141054	1.332[illegible]21	140	15

[illegible].528	2.26[illegible]	[illegible]	[illegible]	[illegible]
6.772	2.259954	1.3[illegible]	142	15
7.017	2.318803	1.3[illegible]313	143	15
7.261	2.377289	1.3[illegible]0275	144	15
7.514	2.437508	1.365075	145	15
7.767	2.497389	1.370528	146	15
8.021	2.556954	1.375663	147	15
8.274	2.616225	1.380507	148	15
8.527	2.675217	1.385084	149	15
8.780	2.733950	1.389415	150	15
9.034	2.792437	1.393518	151	15
9.287	2.850692	1.397411	152	15
9.549	2.910726	1.401233	153	15
9.811	2.970539	1.404862	154	15
10.073	3.030143	1.408312	155	15
10.335	3.089549	1.411595	156	15
10.597	3.148766	1.414723	157	15
10.859	3.207805	1.417705	158	15
11.120	3.266675	1.420552	159	15
11.382	3.325382	1.423272	160	15
11.644	3.383936	1.425874	161	15
11.906	3.442342	1.428363	162	15
12.168	3.500608	1.430748	163	15
12.439	3.560675	1.433109	164	15
12.710	3.620606	1.435370	165	15
12.980	3.680405	1.437539	166	15
13.251	3.740079	1.439619	167	15
13.522	3.799633	1.441617	168	15
13.792	3.859071	1.443536	169	15
14.063	3.918399	1.445381	170	15
14.334	3.977621	1.447156	171	15
14.604	4.036742	1.448865	172	15
14.875	4.095764	1.450511	173	15
15.128	4.155968	1.451682	174	16
15.347	4.215936	1.452162	175	16
15.565	4.275904	1.452621	176	16
15.783	4.335873	1.453062	177	16
16.002	4.395842	1.453484	178	16
16.220	4.455810	1.453890	179	16
16.438	4.515778	1.454280	180	16
16.447	5.515778	1.454309	181	16
16.456	6.515778	1.454338	182	16
16.464	7.515778	1.454367	183	16
16.473	8.515778	1.454396	184	16
16.482	9.515778	1.454425	185	16
16.491	10.515778	1.454454	186	16
16.499	11.515778	1.454483	187	16
16.508	12.515778	1.454512	188	16
16.517	13.515778	1.454541	189	16
16.525	14.515778	1.454570	190	16
16.534	15.515778	1.454599	191	16
16.543	16.515778	1.454628	192	16
16.552	17.515778	1.454657	193	16
16.560	18.515778	1.454686	194	16
16.569	19.515778	1.454715	195	16
16.578	20.515778	1.454744	196	16
16.587	21.515778	1.454773	197	16
16.595	22.515778	1.454802	198	16
16.604	23.515778	1.454831	199	16
16.613	24.515778	1.454860	200	16

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248.20

MAXIMUM SLENDERNESS RATIOS

RUN NUMBER 77

INPUT DSI=0.120000 FIC=0.200000

CASE NUMBER 77. 1 QLL= 40.0000 QIR= 0.08119 PHC1=0.3519

CURV	L/R	X/R	Y/R	MOM
0.979072	124.236041	124.229472	0.195675	-1.126545
2.206606	89.576243	89.551195	0.160617	0.

CASE NUMBER 77. 2 QLL= 160.0000 QIR= 0.36537 PHC1=0.5253

CURV	L/R	X/R	Y/R	MOM
2.775581	74.022600	74.010978	0.603648	-1.142526
3.344507	54.069902	54.061828	0.430176	0.

CASE NUMBER 77. 3 QLL= 320.0000 QIR= 0.64954 PHC1=0.6970

CURV	L/R	X/R	Y/R	MOM
3.400072	57.711360	57.704565	0.414139	-1.141404
4.046881	42.600399	42.595524	0.298548	0.

CASE NUMBER 77. 6 QLL= 110.0000 QIR= 0.22328 PHC1=0.4388

CURV	L/R	X/R	Y/R	MOM
2.286803	90.381065	90.364433	0.825800	-1.139711
2.783923	65.139026	65.127152	0.569009	0.

EXIT CALLED.
CARDS REMAINING IN DECK ARE--
END OF DATA

AUG 15 67 21 11.3
RUN TIME 0008.2 MIN.
AUTHORIZED TIME LEFT IS .013 HR 38.9 MIN

248.20

DSLL=0.2456 FOL=0.2868

SLOPE	P	ENDS
0.	1.300302	FIXED
0.034691	1.300486	S.S.

DSLL=0.1476 FOL=0.2868

SLOPE	P	ENDS
0.	1.301386	FIXED
0.024553	1.300980	S.S.

DSLL=0.1119 FOL=0.2868

SLOPE	P	ENDS
0.	1.301677	FIXED
0.021435	1.301209	S.S.

DSLL=0.1888 FOL=0.2868

SLOPE	P	ENDS
0.	1.301150	FIXED
0.027506	1.300792	S.S.